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Leaf-Strip Harvester for Alfalfa

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Abstract
While exact percentages of protein and fiber in alfalfa vary with soil and weather conditions, stage of growth, and variety, the leaves contain up to 75 percent of the total plant protein. The superior quality of the alfalfa leaves emphasizes the importance of reducing the high leaf loss common in present haying methods.

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LEAF-STRIP HARVESTER FOR ALFALFA

WHILE exact percentages of protein and fiber in alfalfa vary with soil and weather conditions, stage of growth, and variety, the leaves contain up to 75 percent of the total plant protein. The superior quality of the alfalfa leaves emphasizes the importance of reducing the high leaf loss common in present haying methods.

A two-roll stripping method (Fig. 1) was selected for development. Preliminary analysis showed that if the alfalfa plant could be bent or pushed toward the machine a double-roll hay conditioner would pull the alfalfa plant into the machine between the rolls. As the machine moved forward, the stems would pull from between the rolls and out around the lower roll. Observation of the stripping action indicated that the leaves were stripped while the plants were between the rolls and as they were pulled from between the rolls. Thus, by modifying the rolls to include a stripping mechanism and by providing a feeding device, leaves could be stripped with a modified hay conditioner. A New Holland 404 crusher was furnished by the New Holland Machine Company for this research work. This crusher was equipped with a 12-in. smooth steel upper roll and 8-in. diamond-treaded rubber lower roll.

The feeding device was a combine windrow pickup attachment. The canvas belt, with attached spring teeth, was reversed to pull the plant under the draper. The unit was then mounted in front of the crusher (Fig. 2). The relative speed of the canvas teeth to the ground speed was approximately two to one. This feeding arrangement:

- Headed the tops of the alfalfa plant into and between the rolls
- Untangled lodged and tangled plants
- Positioned plants parallel to the direction of travel so their machine entry would be perpendicular to the axis of the stripping rolls

The stripping mechanism was a heavy rubber doormat. Doormats with ½ in. finger-like projections were glued and bolted to the upper roll. Alternate rows of projections were removed along the roll (Fig. 3) so that any stem which did not enter the roll perpendicular to the axis could slide along the roll and out around the projection it was bent around. The spacing between the rolls was set so the projections on the mat just touched the lower roll. Roll speed during harvest was approximately 550 rpm.

A box, Fig. 4, was built behind the rolls to collect the leaves as they were stripped from the stems. A brush and a deflection board, Fig. 3, cleaned the mat and kept leaves

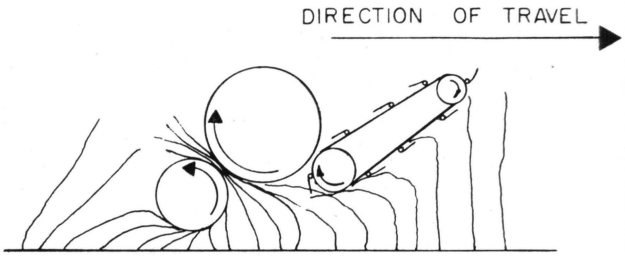

Fig. 1 Predicted flow of standing alfalfa crop under draper and into and out of hay conditioner rolls

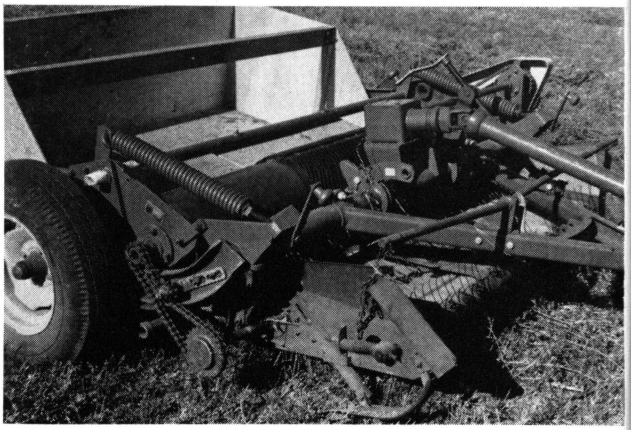

Fig. 2 Location of belt pickup attachment on hay crusher

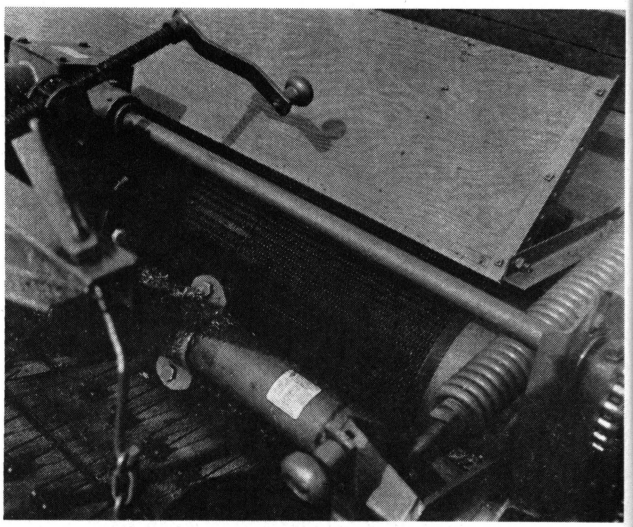

Fig. 3 Rubber door mat with alternate rows of teeth removed

Fig. 4 Stripping alfalfa leaves from an experimental plot

from continuing around the roll. Further description of the machine's development is given by Currence (2).*

Experimental Procedure

This machine was used to harvest three different crops – the second and third cuttings in established alfalfa and the second cutting in alfalfa seeded the previous fall. Plots were approximately 52 in. wide by 50 ft long and were prepared by cutting alleyways with a self-propelled windrower. The treatments were *(a)* mowing and *(b)* strip harvesting. For the mowing treatment, the crop was handled in this way: The mowed plots were harvested with a flail-type field chopper. A sample was taken for moisture and chemical analysis. For strip harvesting treatment plots were stripped with the leaf-stripping machine and material (leaves plus broken stems) weighed. Samples were collected for moisture and chemical analysis. The stems remaining after stripping were harvested with the flail chopper, weighed and sampled.

The samples collected were 1 to 2 lb (wet weight). These were weighed to the nearest gram, then dried in an oven at 135 F for a minimum of 72 hr. Dried samples were weighed to the nearest gram, ground with a Wiley mill using a medium-mesh screen (approximately 40 holes per sq in.) and mixed thoroughly.

Nutrient analyses were made on samples taken from 2-oz jars of ground material. Samples were analyzed chemically in the Agronomy Laboratory, Iowa State University, for crude protein and crude fiber percentages. A modified micro-Kjeldahl method described by Perrin (6) was used to determine nitrogen content. The nitrogen content was multiplied by 6.25 to obtain the percentage of crude protein. The method of analysis presented by the Association of Agricultural Chemists (1) was used to determine the percentage of crude fiber.

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*Numbers in parentheses refer to appended references.

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Discussion of Results

To evaluate the efficiency of the stripping process, the weights of the stripped material were compared with the weight of the stems harvested after the leaves were stripped, Fig. 5. The relationship between the amount of stripped material and the material harvested after stripping was not 1:1 as would be expected with 100 percent separation of the leaves and stems. However, the alfalfa had been infected with leaf spot and many of the lower leaves had fallen off. Also, some of the leaves stripped were lost in front of the collection box. Those leaves on the ground were picked up with the chopper as the stems were cut, thus contributing to the greater gross weight of the chopped material rather than to the total weight of the stripped material. Thus, the yield and the protein content of the stems were increased by these loose leaves. By visual inspection it was estimated that, on the average, 90 percent of the leaves were removed from the stems by the stripping process and that the stripped product was 85 to 95 percent leaves. Representative samples of the stripped product, stems harvested after stripping, and the whole plant harvested with the flail-type chopper are shown in Figs. 6, 7, and 9.

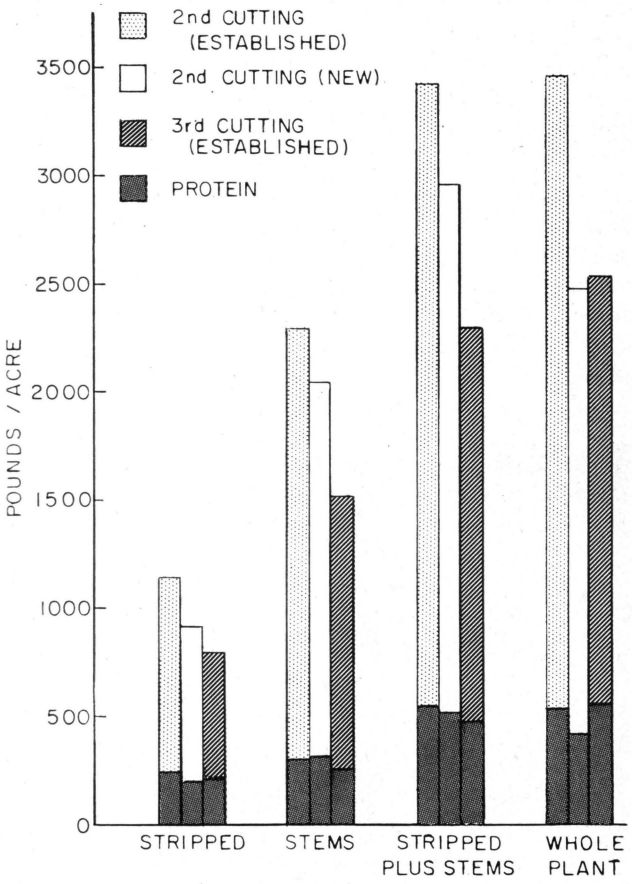


Fig. 5 Average yields of dry matter and protein

. . . Leaf Strip Harvester

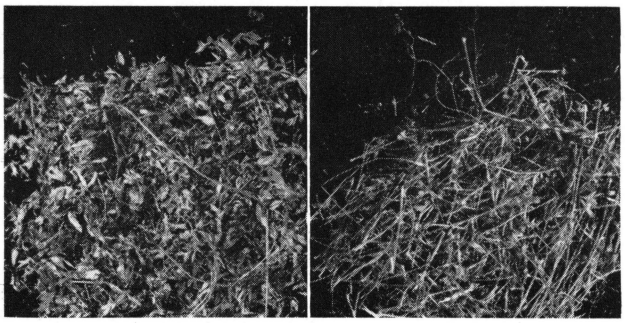


Fig. 6 Sample of stripped material, third cutting • Fig. 7 Sample of material (stems) harvested after stripping, third cutting

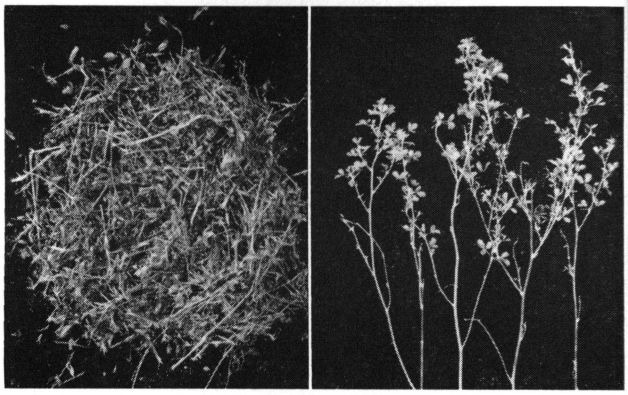
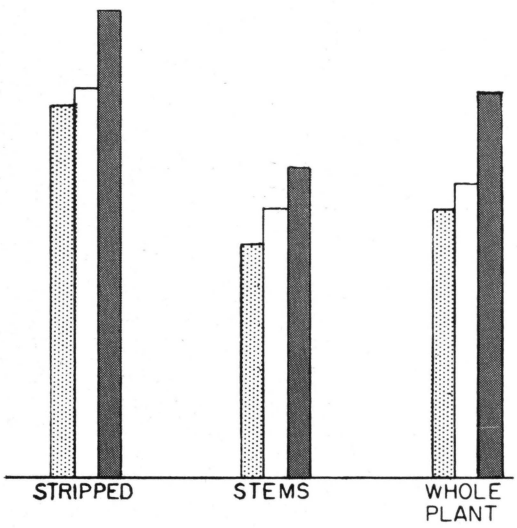


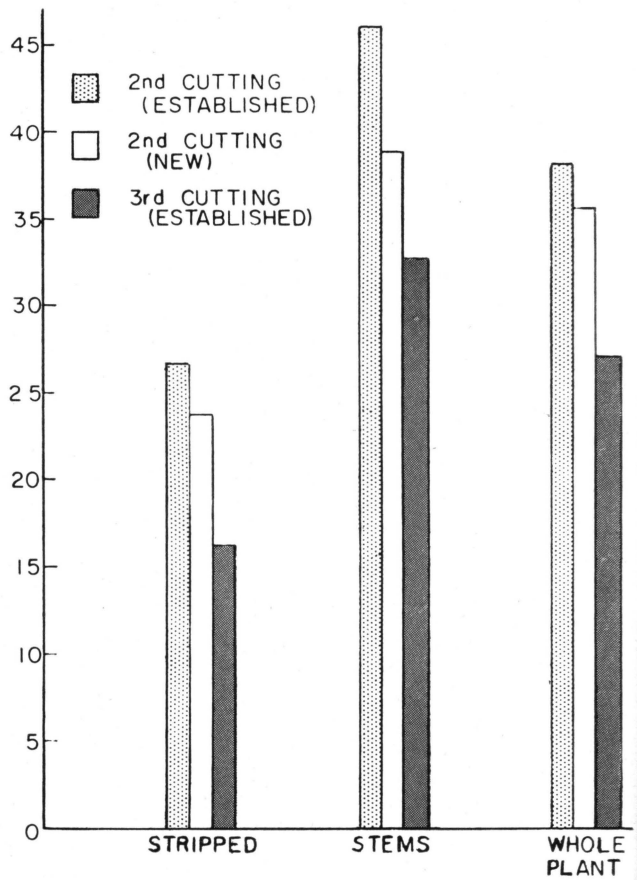
Fig. 9 ***(Left)*** Whole plant harvested with a flail chopper; third cutting • Fig. 10 ***(Right)*** Leaf regrowth on stripped stems after second cutting

The average percentage of crude protein for each of these harvests is presented in Fig. 8, with the percentage given for the stripped leaves, for the stems, and for the whole plant. In Fig. 8 also the percentage of crude fiber is presented for the stripped leaves, stems, and whole plants. Note that the stripped material is higher in protein and lower in crude fiber than the stems harvested after stripping with the whole plant ranging in between. As previously noted, this stripped material should make up about half the weight. Fig. 5 shows the pounds per acre of crop material and protein harvested from each cutting, with the amounts for the stripped leaves, stems, stripped leaves plus stems, and whole plant given. The yield of protein from the stripped material is nearly the same as the yield from the stems left after stripping, with the total amount of material handled in the case of stems about twice that of stripped material. The comparison between the stripped leaves plus stems harvested after stripping and the whole plant shows that the total material and the total protein were approximately the same in both cases.

An additional feature of this strip harvesting procedure was the growth pattern of the stems after stripping. A number of plots were stripped and left undisturbed to grow new leaves. Leaves grew back quickly, completing regrowth in approximately 2 weeks. These leaves, however, were smaller than the original leaves; typical regrowth after stripping is shown in Fig. 10. Since the stripping was done after the alfalfa had bloomed, the small size of the regrown leaves may have been due to the maturity of the plant at stripping. Possibly plant regrowth patterns would change if stripping were done in the earlier stages of plant maturity. If this regrowth should amount to a sizable yield of leaves after the first stripping, it might be possible to strip twice and then harvest the stems, thus increasing the protein yield as well as the tonnage of high-quality material harvested for the growing season.

Fig. 8 ***(Below)*** Percent Crude Protein ***(Right)*** Percent crude fiber





Conclusions

Analysis of the laboratory and field tests of the alfalfa leaf stripper reveals that:

- Alfalfa leaves can be stripped from the stem with a field machine
- The amount of stems in the stripped product, and thus the quality of the product, can be controlled by adjusting the aggressiveness of the rolls by either placing them closer together or increasing the rpm of the rolls
- The stems left after stripping will grow new leaves
- Stripped stems regrow leaves in approximately 2 weeks; however, the leaf regrowth is small when the plant has bloomed before stripping
- Lodged alfalfa plants may be satisfactorily stripped
- Stripped material from the leaf-strip harvest has higher nutrient content and lower fiber content than the whole plant
- The product from a hay harvester employing a leaf-strip gathering device could be commercially valuable as a low-fiber, high-protein feed
- The stems (after stripping) contain sufficient nutrients for animal roughage

References

1 Association of Official Agricultural Chemists. Official methods of analysis. 1960.

2 Currence, H. David. Development of a leaf-strip harvesting system for alfalfa. MS thesis, Iowa State University of Science and Technology, 1964.

3 Dent, J. W., and Zaleski, A. Leafiness and chemical composition of some Lucerne strains. British Grassland Society Journal 9:131-140, 1954.

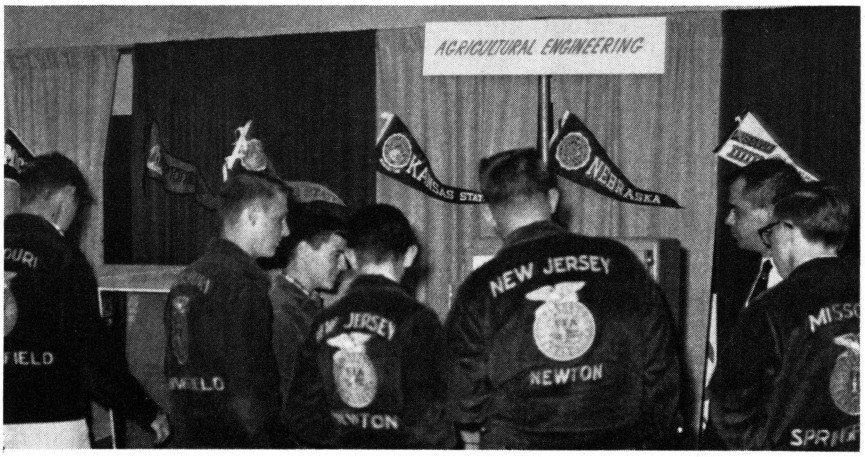
4 Morrison, Frank B. Feeds and feeding. Morrison Publishing Co. (22nd edition) 1959.

5 Pedersen, T. T., and Buchele, W. F. Drying rate of alfalfa hay. AGRICULTURAL ENGINEERING 41:86-89, 107-108, 1960.

6 Perrin, C. H. Rapid modified procedure for determination of Kjeldahl nitrogen. Analytical Chemistry 25:968-971, 1953.

7 Sotola, Jerry. The nutritive value of alfalfa leaves and stems. Journal of Agricultural Research 47:919-945, 1933. ● ●

ASAE and an FFA SHOW STOPPER



How to sell the high schooler on an agricultural engineering career? University of Missouri Ag Engineer Donald Brooker accepted this task for ASAE and its Mid-Central Region's Career Guidance Committee, which he heads. Over 2500 ASAE leaflets were distributed at the recent Future Farmers of America convention in Kansas City. Also helping develop ASAE's exhibit were educators Ralph Lipper and H. B. Pfost of Kansas State, E. A. Olson of Nebraska, David Palmer of Iowa State, plus Elmer Smith of Kansas City Power & Light Co. and C. D. Powell of Western Mercantile Co. Over 11,000 attended this event. Please refer to further comments in Check Points on page 54.

Examining the Hyatt bouncing ball bearing exhibit *(below)* with Prof. Brooker, right, is Kentuckian Charles W. Marshall, center, National Farm Electrification Award Winner, and his father. Below right, Kenneth L. McFate, Mid-Central Region chairman, talks with an FFA member; others are shown above. Three projection boxes with carrousel projectors showed slides of agricultural engineers at work and highlighted career opportunities. Helping also to man the booth were V. J. Morford, U. E. Wendorff, and Larry Axthelm